AXIAL LOAD OF SIGMA SECTION COLD-FORMED STEEL WITH AN OPENING

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STUDENT’S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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ABSTRAK

Kertas kerja ini membentangkan mengkaji tingkah laku lengkokan seksyen sigma tunggal sejuk terbentuk dengan pembukaan. keluli sejuk terbentuk adalah istilah umum untuk produk yang dibuat oleh bergolek atau menekan keluli menjadi barang separuh siap atau siap pada suhu yang agak rendah. Kaedah yang digunakan untuk eksperimen ini adalah ujian mampatan. Spesimen tiang telah dimampatkan antara dua plat galas dengan hujung rata. nombor 8 spesimen dengan ketinggian 600 mm yang 4 dengan pembukaan dan lain 4 tanpa pembukaan. Bentuk bukaan yang digunakan adalah bulatan dan saiz yang dikekalkan malar. Kekuatan beban muktamad seksyen keluli sejuk terbentuk dan mod kegagalan berbeza bergantung kepada saiz dan pembukaan, di mana kesimpulan yang membuat berdasarkan perbandingan antara saiz spesimen dan bukaan. Transduser digunakan untuk membaca anjakan spesimen semasa ujian di mana graf telah diplot. beban - kajian Graf anjakan beban muktamad spesimen. Spesimen antara pembukaan dan tanpa pembukaan saiz yang sama telah membuat perubahan kepada keputusan tetapi perbezaan tidak menyatakan banyak berbeza kerana hanya satu dibuka pada pertengahan spesimen. lengkokan tempatan dan lengkokan distortional boleh dilihat pada spesimen. lengkokan tempatan hanya berlaku pada spesimen yang tidak mempunyai bukaan manakala bagi spesimen yang mempunyai bukaan, lengkokan distortional berlaku di mana flanged memutarbelitkan zahir atau batin dapat dilihat.

ABSTRACT

This paper presents study the buckling behaviour of cold-formed single sigma section with an opening. Cold-formed steel is the common term for products made by rolling or pressing steel into semi-finished or finished goods at relatively low temperatures. The method used for this experiment are compression test. The column specimens were compressed between two bearing plates with flat ends. 8 number of specimens with height of 600 mm which are 4 with an opening and another 4 without opening. The shape of openings used are circle and the size is kept constant. The ultimate load strength of the cold-formed steel section and failure modes differs depend on the size and an opening, where the conclusions are make on the basis of the comparisons between the size of the specimens and the openings. Transducers used to read the displacement of the specimen during testing where the graph had been plotted. The load – displacement graph study the ultimate load of the specimens. The specimens between opening and without opening of the same size did make a difference to the results but the difference did not varies much due to only one opening at the middle of the specimen. Local buckling and distortional buckling can be seen at the specimen. Local buckling only happen at the specimen that did not has openings while for specimen that have openings, distortional buckling occurred where the flanged distort outward or inward can be seen.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

In the past years, cold-formed channel studs had been chosen as the option for a cross section for load bearing compression members by the designers and contractors. Cold formed steel sections are widely available with difference sizes and shape. Cold formed steel sections are manufactured with difference process such as folding, press-breaking and rolling. The thickness for steel sheets or strip sold-formed used ranges from 0.4 mm to about 6.4 mm whereas thicker steel plates and bars cold-formed with the thickness 25 mm can be successfully into structural shapes.

The ultimate strength and elastic stiffness of structural members can vary with perforations made especially for fastens such as bolts, screws, to make the member economical. The yield strength and tensile strength of the cold formed steel section increases but ductility decreases specially the corners. Recently, sigma shaped section has been used as the alternative to the channel section. This is because sigma shaped section have an intermediate web return and multi stiffeners. The main functions of these individual structure framing sections are to carry structural strength, load and stiffness for design purposes.

1.2 Problem Statement

Thin-walled cold-formed columns are widely used in engineering industry. Cold-formed structure has thinner and lightweight compared to hot-rolled members. This will lead cold-formed structure to an economic design than hot-rolled. This is due to its weight ratio of the structure and ease of construction. Another advantages of cold-formed structure are high strength and stiffness, uniform quality, ease of prefabrication and mass production, economy in transportation and handling, fast and easy erection and installation and its flexibility in forming different cross-section shapes. However, this flexibility makes the section difficult for a particular situation. Besides, cold-formed steel structures have complex design consideration as it shows in various design standard. However, these design rules of cold-formed were based mainly on experimental investigation. Figure 1.2 shows that house made up from cold-formed steel and Figure 1.3 shows that cold-formed steel framing.

In cold-formed members type families, typical type of cold-formed structure which is C-section has commonly encountered in normal structural steel design and make them easy to find globally whereas sigma section are hardly find in market especially in Malaysia. Meanwhile, channel and sigma sections are considered as the sensitivity of the conventional stability solution compared to C-section. Cold-formed sigma section has an optimum design structure because of the intermediate web return and multi stiffeners. The problem with the optimal design is the selection and size which the design considers as the complex and highly nonlinear constraints. This is due reduction of area of opening installation may affect the strength of the section.

A thin-walled cold-formed member under compression, there will be a possibility of local buckling to occur. Below shows the modes of failure other than local buckling:

1. Distortional buckling
2. Flexural buckling
3. Torsional buckling
4. Flexural-torsional buckling

Figure 1.1 House made up from cold-formed steel

Figure 1.2 Cold-formed steel framing

REFERENCES

(Crisan, Ungureanu, & Dubina, 2012) Crisan, A., Ungureanu, V., & Dubina, D. (2012). Behaviour of cold-formed steel perforated sections in compression. Part 1 - Experimental investigations. Thin-Walled Structures, 61, 86–96. https://doi.org/10.1016/j.tws.2012.07.016

(El Aghoury, Hanna, & Amoush, 2017)El Aghoury, M. A., Hanna, M. T., & Amoush, E. A. (2017). Experimental and theoretical investigation of cold-formed single lipped sigma columns. Thin-Walled Structures, 111(October 2016), 80–92. https://doi.org/10.1016/j.tws.2016.10.025

(Gholipour, 2011)Gholipour, Y. (2011). Section optimization of cold-formed steel columns with stiffeners, 2(8), 199–209.

Kim, J. H., Lee, M. G., Kim, D., Matlock, D. K. and Wagoner, R. H. 2010. Hole-expansion formability of Dual-Phase Steels using Representative Volume Element Approach with Boundary-Smoothing Technique. Materials Science and Engineering. 527(27-28): 7353-7363.

(Kwon, Kim, & Hancock, 2009)Kwon, Y. B., Kim, B. S., & Hancock, G. J. (2009). Compression tests of high strength cold-formed steel channels with buckling interaction. Journal of Constructional Steel Research, 65(2), 278–289. https://doi.org/10.1016/j.jcsr.2008.07.005

(Meiyalagan, Anbarasu, & Sukumar, 2010)Crisan, A., Ungureanu, V., & Dubina, D. (2012). Behaviour of cold-formed steel perforated sections in compression. Part 1 - Experimental investigations. Thin-Walled Structures, 61, 86–96. https://doi.org/10.1016/j.tws.2012.07.016

Meiyalagan, M., Anbarasu, M., & Sukumar, S. (2010). Investigation on Cold - formed C - section Long Column with Intermediate Stiffener & Corner Lips – Under Axial Compression. International Journal of Applied Engineering Research, Dindigul, 1(1), 28–41.

(Nguyen & Kim, 2009)Kwon, Y. B., Kim, B. S., & Hancock, G. J. (2009). Compression tests of high strength cold-formed steel channels with buckling interaction. Journal of Constructional Steel Research, 65(2), 278–289. https://doi.org/10.1016/j.jcsr.2008.07.005

Shanmugam, N. E., & Dhanalakshmi, M. (2001). Design for openings in cold-formed steel channel stub columns. Thin-Walled Structures, 39(12), 961–981. https://doi.org/10.1016/S0263-8231(01)00045-3

Wang, H. and Zhang, Y. 2009. Experimental and numerical investigation on cold-formed steel C-section flexural members. Journal of Constructional Steel Research. 65(5): 1225-1235.

Yan, J., & Young, B. (2002). Column Tests of Cold-Formed Steel Channels with Complex Stiffeners. Journal of Structural Engineering, 128(6), 737–745. https://doi.org/10.1061/(ASCE)0733-9445(2002)128:6(737)

(Yu & Laboube, 2010). Yu, W., & Laboube, R. A. (2010). Cold-Formed Steel Design.